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STUDY ON DURATION OF MEASURABLE PRECIPITATION AT BIRMINGHAM

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1. Introduction

The purpose of this study is to show the value of using climatological statistics in the improvement of precipitation forecasts by the establishment of practical guidelines of duration probability.

The forecasting of precipitation duration is one of the prime problems confronting Meteorologists in general. The forecasting of the most likely time of onset is only half the problem. "Just how long will it last?" is the next question the user public will ask. Due to the adverse effect of precipitation on the public in general there is a natural tendency for Meteorologists to overforecast both occurrence and duration. Many of the more qualified thinkers in the field of meteorology have voiced this opinion. It is frequently noted that rain will be continued in a forecast until all shadow of doubt of its ending is removed; and in some cases even after the current synoptic situation has obviously ceased to produce the phenomena. In view of these considerations it is hoped that this study can provide some practical guidelines during periods of uncertainty when present day forecasting techniques fall short of providing an adequate practical answer.

Most Meteorologists would agree that synoptic situations which produce short to moderate duration periods of precipitation offer the least difficulty in prediction. In these cases timing of onset presents the greatest difficulty. On the other hand the stagnant or slow moving systems with perhaps complicated, out-of-phase, upper air structures offer the real challenges and prove the most difficult in arriving at a confident decision as to length of duration. There are a few rain producing situations which seem to have no dynamic or synoptic indications as to when it will end or change appreciably. In these cases it is frequently not a change in the surface or upper air patterns which brings precipitation to an end, but the fact that available moisture is finally depleted despite an apparent continued moisture source. In layman's terminology "It finally rains itself out".

It is during periods of uncertainty in dynamic or synoptic considerations that climatology can play its most effective role as a guideline tool in forecast decision making by offering statistics on past experience to give practical expectations and/or probability of occurrence in view of the current situation. Again, it is the purpose of this study to offer these guidelines to the Meteorologist for improvement of forecasts especially during periods of complicated weather producing situations when decision making is most difficult. It should be recognized at the outset that there is no intent to offer climatological parameters as a crutch for lack of sound meteorological reasoning on the part of the forecaster. It is only an accessory tool drawn from past experience to help remove some of the uncertainties where known dynamic and/or synoptic principles fall short of offering the required answer.

2. Data and Procedures

In the present study a 10 year period oc Climatological records was used (1956-1965 inclusive) taken at the municipal airport at Birmingham, Alabama. All periods of measurable precipitation were recorded on an hourly basis and categorized by month of the year. The method used in determining the duration of measurable precipitation was to count the number of hours that .01 inch or more continued until at least 12 hours elapsed without any measurable precipitation being received. This period of 12 hours was chosen more or less arbitrarily on the assumption that a synoptic situation which produced the period of precipitation had ended or moved out of the area after it has ceased to produce the phenomena for a 12 hour period. Any precipitation which might begin again shortly after this 12 hour period was assumed to come from a new development, or a re-development of a dissipating weather producing storm. No proof of this assumption is offered in the present article. Experience however dictates that the assumption should prove out in the vast majority of cases. An additional reason for using the 12 hour period for a cut-off point is the fact that Weather Bureau forecast verification is by 12 hour periods, as are the general periods of separation of forecasts offered the user public; i.e. Today, Tonight, and Tomorrow. It is obvious that a longer cut-off period of say 18 to 24 hours would involve perhaps a continuing chain of synoptic situations and would be of little value, particularly in summer months where timing of afternoon shower onset is variable from day to day.

It will be recognized that measurable precipitation may only occur spasmodically during any one precipitation period with some hours not showing measurable amounts so long as a measurable amount again occurs in less than 12 hours from the last one. In a few of the rain periods recorded as much as 10 to 11 hours elapsed without any measurable amounts yet the rain period was continued for a much longer time due to additional amounts thereafter. By and large, however, the rain periods were persistent with measurable amounts occurring almost every hour. Also, rain periods which began shortly after a 12 hour period of no rain were comparatively minor and in the majority of cases 24 to 48 hours or more ensued before another rain period began after the ending of such period.

In this study no attempt was made to separate rain periods into the standard 12 hour forecast periods in use at Weather Bureau stations. In other words, a 12 hour rain might fall into two 12 hour forecast periods, depending on time of onset, and on rare occasions a rain duration of 13 to 14 hours might verify a forecast of rain in all three 12 hour periods of a 36 hour forecast. In making use of the conclusions arrived at in this study, it should be assumed that a rain duration forecast will be based on the most likely time of onset. That is, if a 12 hour rain is predicted to begin in the middle of a 12 hour forecast period then naturally it would be forecast to last into the second period, or roughly for the first 24 hour period of the forecast

For the 10 year period of study at Birmingham Airport the total number of rain cases for each month was tabulated by number of hours of duration. Next this data was categorized into six or twelve hour groupings, and finally summarized into percentage of occurrence by the different groupings. The latter was arrived at by comparing the number of cases in each period grouping to the total number of rain cases for the particular month. Table 1 shows the total hours of precipitation for the 10 year period by months. The number of rain cases in each month, and the arithmetic mean duration in hours. Also, the longest rain period for each month is shown. Table 2 shows the number of rain cases falling within certain time periods, ranging up to 48 hours of duration. The cases lasting longer than 48 hours were grouped in one column and labeled 'above 48 hrs'. From this latter chart the finalized percentage frequency diagram was prepared showing the percentage of duration for 6, 12, and 24 hour groupings. (see Table 3)

3. Analysis and Conclusions

For the purpose of this study the results shown in Table 1 do not have any great value for practical use in every day forecasting. It does indicate the trend of seasonal variation in normal precipitation duration and the frequency of rain cases to normally expect in each month. The duration of summer months precipitation is about half that found in winter months while the number of rain cases are considerably more. One of the reasons this mean duration does not offer much value in the business of day to day forecasting is the large standard deviation from the mean, month by month. For instance in the months of September and October the mean duration of rain is about twice that of July and August and would indicate that rain situations are typically much longer in these months. The real reason however, for the longer means is due mainly to the effect of tropical storm weather present in this area in these months which give unusually long periods of rain. If these tropical storm situations were taken out the remaining rain cases would be quite short and infrequent rain situations. Charts of figures from Table 2 and 3 however give a much better picture of rain duration expectancy as applied to particular synoptic situations for the different seasons of the year.

In Table 3 the strong seasonal variation in rain duration stands out immediately. Note that in December only 32 percent of the rain cases lasted 6 hours or less, whereas, in July 81 percent of its rain cases ended in 6 hours or less. Extended further, 94 percent of the rain cases in July had a duration of 12 hours or less compared to only 59 percent in December. Interesting comparisons can be made from Table 3 to show the different weather types which frequent the Birmingham area on a monthly and seasonal basis. For instance in looking at December and January it is found that December has normally longer periods of rain. Where January has only 9 cases of rain in 10 years lasting longer than 24 hours, December has 22 cases. Percentagewise, 91 percent of January's rains (or snows) are over in 24 hours or less compared to only 78 percent in December. A probable cause for this is the fact that Polar outbreaks have not reached their maximum strength in December and do not penetrate as far south with the accompanying drier air. Also, the warmer Gulf of Mexico in December offers greater moisture supplies to override the Polar air and give extended warm frontal rains. Further support of this idea is gained from sunshine and cloud cover data for the two months. January is the cloudiest month of the year with lowest percent of possible sunshine indicating frequent warm frontal type weather, but the cooler Gulf does not contain enough available moisture to produce the long duration rains of December. February also has a slight edge over January in the longer rain variety of weather patterns. This might indicate a return of moisture supplies from Southern Gulf regions where the air has again begun to warm up and produce occasional extended warm frontal type weather. In forecasting for the winter months a healthy respect should be given to the mean duration of precipitation as found in Table 1. The probability of rain lasting 12 hours after initial onset is quite high; nevertheless exceptionally long rains beyond the 24 to 36 hour class are quite rare.

Another point of interest comes from the figures for June. Although this is a traditionally summer month with it's share of airmass convective showers, as in July and August, it also receives a considerable amount of comparatively long duration rains produced from frontal systems of the late spring type. Where 76 percent of August's precipitation is over in 6 hours or less, and 81 percent in the case of July, June has only 65 percent of its cases in this category. Longer rain situations are particularly prevalent the first two weeks of June. August does produce some longer rain durations than July and this is perhaps due to occasional tropical storm influence, especially the latter part of the month.

In viewing all months, the sharp drop-off in rain duration is quite noteworthy beyond the first 24 hours after onset. For instance, if a forecaster called for measurable rain continuing beyond the first 24 hours he couldn't expect to verify more than 15 percent of the time except during the month of December where he is given 22 percent chance. In the months of January, May, June, July, August, October and November his climatological verification would show less than 10 percent accuracy over an extended period of time. This is not to say, of course, that a Meteorologist does not have the ability to pick the long rain situations and have a much higher verification than is indicated statistically. It does offer a word of caution to those confronted with a potential long rain period to use all available means at their disposal when predicting extended duration of precipitation.

The accuracy of predicting the initial onset of precipitation will also have to be taken into consideration in the forecasting of probable duration. During the months of the year when extended rain forecasts are most frequent, i.e. late fall, winter and spring, frontal weather is most active and the movement of weather systems is generally more systematic. In the vast majority of cases, time of onset can be pinned down to the most probable six hour period in a 24 hour forecast, and to the nearest 12 hour period for longer predictions. Once this is determined the probable duration period can be ascertained from the type situation, speed of movement, etc., keeping in mind a healthy respect for statistical probability as shown in this climatological study.

It is true that lowest verification will come in those cases where weather systems do not move as forecast, or where complications set in to radically change the associated weather from that which was previously expected. Cold fronts which stall and begin moving slowly northward as warm fronts are often unpredictable. Radical changes in upper air patterns that associate themselves with surface systems can bring a corresponding radical change in weather producing storms. It is during periods of comparative uncertainty in expected changes of weather producing systems that a healthy respect for climatological means can improve a forecast product, especially on the long range basis. For instance, if a current synoptic situation indicates a high probability of an unusually long rain period it would help to know that in the month of January there had been no cases of continuous measurable rain lasting beyong 48 hours in a ten year period at Birmingham,and only three cases where rain lasted beyond 36 hours. In this case if the Meteorologist forecast rain to stop before the end of 36 hours after onset he could expect to be right 96 percent of the time. If he forecast rain to end within 24 hours he would be right 91 percent of the time on the average.

In considering the weather types which produce precipitation of different durations it may be an advantage to consider the normal expectation of precipitation in all other cases except the short duration type (1 to 6 hours). A tabulation was made of all the hours of rain beyond the 1 to 6 hour class in January and July for the 10 year period. The results show that the mean duration was 17 hours in January and 15 hours in July. This shows a radical difference in the means when all rain cases are included. For all cases the mean duration in January is 11 hours compared to only 4 hours in July. This would indicate about as long duration rains in summer from frontal or other complicated weather systems as is found in winter - once the short duration rain cases are taken out of the means.

There are of course many other possibilities for interesting comparisons of possible use to the individual forecaster which are not included in this article, but these are left to the Meteorologist to determine as it best suits his individual need. Although this study was designed specifically for Birmingham, Alabama and the surrounding area, it is felt that favorable application of the results may be had in other areas of similar climates throughout the Gulf States.

TABLE 1

MEAN DURATION OF PRECIPITATION IN HOURS BY MONTH
(10 Year period 1956 through 1965) WBAS, Birmingham, Alabama

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
Mean Dur. in Hrs.	11	12	11	11	8	7	4	5	10	10	9	13	9
Extreme Duration	46	71	43	53	38	52	32	41	64	57	40	50	
Total Hrs. Precip.	850	941	1006	711	511	622	554	410	610	489	571	856	
No. Precip. cases	75	76	91	67	66	85	124	82	62	49	64	66	

TABLE 2

NUMBER OF RAIN CASES FALLING WITHIN CERTAIN HOURS OF DURATION
(10 Year period 1956 through 1965) WBAS, Birmingham, Alabama

	1-6	6-12	12-24	24-36	36-48	Above 48	Total Cases
January	30	20	18	4	3	0	75
February	32	14	21	4	3	2	76
March	41	17	22	8	3	0	91
April	37	8	12	9	0	1	67
May	42	9	12	2	1	0	66
June	55	16	9	3	1	1	85
July	100	16	5	3	0	0	124
August	62	9	9	1	1	0	82
September	40	8	6	4	2	2	62
October	24	10	11	2	1	1	49
November	28	18	15	2	1	0	64
December	21	18	13	13	0	1	66

TABLE 3

DURATION PERCENTAGES FOR DIFFERENT PERIODS OF TIME
(Precipitation occurrences for Birmingham WBAS 1956-1965)

	1-6	6-12	12-24	24-36	36-48	Abv 48	1-12	1-24	1-36
January	40	27	24	5	4	0	67	91	96
February	42	18	28	5	4	3	60	88	93
March	45	19	24	9	3	0	64	88	97
April	55	12	18	13	0	1	67	86	99
May	64	14	18	3	2	0	78	95	98
June	65	19	11	4	1	1	84	94	98
July	81	13	4	2	0	0	94	98	100
August	76	11	11	1	1	0	87	98	99
September	65	13	10	6	3	3	78	88	94
October	49	20	22	4	2	2	69	92	96
November	44	28	23	3	2	0	72	95	98
December	32	27	20	20	0	2	59	78	98
All months	55	18	18	6	2	1	73	91	97

Note: The figures above are expressed in percentages from 0 to 100. Some of the months did not equal 100 percent due to the difference in sampling. The figures for April total 99 percent, May 101 percent, June 101 percent, October 99 percent, and December 101 percent. This resulted from the system of rounding off percentages in each category from the raw data.

Explanation of Data: Take January for example: 40 percent of the rain cases during the 10 year period of study lasted from one to six hours, 27 percent lasted from 6 to 12 hours etc., or together 67 percent of the rain cases had a duration of 12 hours or less. The chart to the right shows cumulative percentages. In January 91 percent of the rain cases were over in 24 hours while 96 percent of the cases ended within 36 hours from onset.